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SERVO SYSTEM OF COMBINED CONTROL.(U)
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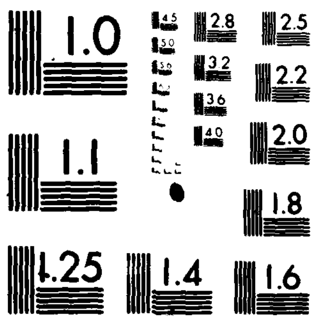

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FOREIGN TECHNOLOGY DIVISION

SERVO SYSTEM OF COMBINED CONTROL

by

B.V. Novoselov, Yu.S. Gorokhov, and A.A. Kobzev

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U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

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SERVO SYSTEM OF COMBINED CONTROL

B. V. Novoselov, Yu. S. Gorokhov,
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The invention relates to the automatic control systems (servo systems of combined control - SSKR) and is intended for high-quality reproduction of compound signals entering the input of the system in the form of voltages with stationary random interferences in the input signal.

There are servo systems of combined control, which are comprised of a comparison element and blocks of primary circuit of the servo system, and also a first differentiator connected to the output of the servo system, whose output is connected to the unit with a controllable saturation point. The unit with a controllable saturation limit is connected to the input of the block of primary circuit of the servo system and to a second differentiator connected to the input of the blocks of primary circuit of the servo system through a second unit with a controllable saturation point.

Systems of this type with good quality of transient processes and necessary dynamic accuracy filter out the interferences poorly because they have a wide passband, and, conversely, with a sufficiently good filtration of noise in the input signal, they have lengthy transient processes when processing the input effect (VV) of type 1 (t) and low dynamic accuracy due to the narrow passband of the system.

The system being proposed is different in that it is provided with a self-tuning circuit comprised of the series-connected high-frequency filter and averager whose output is connected to the second differentiator, while the input of the filter is connected to the output of the comparison element.

The incorporation of this type of the self-tuning circuit makes it possible to obtain the necessary accuracy of reproduction of a useful VV in the operating frequency band by varying the passband of the system depending on the parameters of the useful input effect (VV), and ensure the best filtration of the interference at the assigned VV, which will improve the performance indices of the SSKR considerably (good operation, power consumption, etc.).

Figure 1 shows a block diagram of the said servo system for combined control; Fig. 2 shows a change in the SSKR's passband when the time of the differentiating link is varied.

The system is comprised of a comparison element 1, which generates the error signal; blocks 2 of primary circuit of the SSKR which consist of the power elements and correcting devices; a first differentiator 3 with the transfer function $K_1(P)=\alpha p$, where α is the amplification factor and P - differentiation operator; block 4 with a controllable saturation point; block 5 for separating a slowly changing component of the desired signal; a second differentiator 6 having the transfer function

$$K_2(P)=\frac{\beta TP}{1+TP} \qquad (1)$$

with the controllable differentiation time constant T and amplification coefficient β; block 7 with a controllable saturation point; block 8 for separating a slowly changing component of the desired signal; high-frequency filter 9; and an averager 10 consisting, for example, of a full-wave rectifier and a filter separating the voltage, which is proportional to the error of the system, used to control the amplification coefficient β and differentiation time constant T.

The operating principle of this system is based on that property of the SSKR where the null steady errors occur at different parameters of the compensating devices.

In a linear servo system of combined control, block of primary circuit 2 and the differentiators 3 and 6 have the following transfer functions:

$$K(P)=\frac{K_0(1+T_3P)}{P(1+T_1P)(1+T_2P)},$$

$$K_1(P)=\alpha P,$$
$$K_2(P)=\frac{\beta TP}{1+TP}. \qquad (2)$$

After the transformations, the conditions where the first error coefficients equal zero are satisfied when

$$\alpha=\frac{1}{K_0},$$
$$\beta=\frac{T_1+T_2-T_3}{K_0T}. \qquad (3)$$

The passband of the system changes considerably with a change in the differentiation time constant T of the differentiator 6.

Figure 2 shows the amplitude-frequency characteristics of the system examined in this example:

K_0=8.54; T_1=1.2 s; T_2=0.289 s; T_3=0.0138 s; T=0.001 s (curve 11) and T=0.5 s (curve 12).

The system with a narrow passband, which corresponds to curve 12, filters the interference well but, at the same time, has a lower dynamic accuracy when processing the useful VV of the type $Q(t)=\Theta_{1m}\sin\omega t$. Such an amplitude-frequency characteristic of a system is required when dealing with constant velocities and VV with a low frequency. In this case the error from a useful VV proves to be small, while filtration of the interference is the best.

The SSKR with the amplitude-frequency characteristic, which corresponds to curve 11, has a higher accuracy when producing a useful VV but its filtration of the interference is much worse. Such a characteristic of a system is required when producing a useful VV of the type $\Theta_1(t)=\Theta_{1m}\sin\omega t$ with the maximum amplitude and frequency of the VV.

If the type and parameters of the useful VV change rather slowly, the incorporation of the self-tuning circuit, which changes the passband of the system by varying the time constant and amplification factor of the differentiator 6 in accordance with dependence (3), yields a considerable effect.

The operating principle of the combined-control servo system based on this scheme is as follows.

Let a VV in the form of $\Theta_1(t)=\Omega_1 t+n(t)$, enter the input of the SSKR, where n(t) is a steady-state random interference of the white-noise type. The system's error discriminated by the comparison element is determined only by the interference. The high-frequency components of the interference are filtered by the filter 9, while the low-frequency components enter the averager 10. The voltage at the output of the averager is determined by the interference value. With the given VV the parameters of the differentiator 6 are selected such that the SSKR would have a minimal passband (T is maximum) i.e., best interference filtration is ensured.

If the input effect $\theta_1(t)=\theta_{1m}\sin\omega t+n(t),\ \omega>1$, where $\theta_{1m}\sin\omega t$ is a steady, random, white-noise-type interference, enters the input of the system, the error discriminated by the comparison element consists of the error from the useful VV, which has low-frequency components, and the error determined by the interference.

The averager 10 now receives a high value and the voltage at its output increases. If the error at the given VV exceeds the permissible value, i.e., the voltage at the output of the averager 10 exceeds a specified value, this voltage changes the time constant of the differentiator 6 and increases the passband so that the error would not exceed the permissible value at the end of the transient process.

The accuracy of reproduction of a useful VV and optimum interference filtration are maintained at the specified level when the change in the VV parameters in the SSKR is slow.

Patent Claims

The combined-control servo system, which is comprised of a comparison element and blocks of primary circuit of the servo system, and also a first differentiator connected to the input of the servo system, whose output is connected to a unit with a controllable saturation point which is connected to the input of the blocks of primary circuit of the servo system and to a second differentiator connected via the second unit with a controllable saturation points to the input of the primary-circuit blocks of the servo system, is **distinguished** by the fact that to achieve optimum filtration of the interference in the input signal at a given dynamic accuracy of the system, it is equipped with a self-tuning circuit comprised of the series-connected high-frequency filter and averager whose output is connected to the second differentiator, while the input of the filter is connected to the output of the comparison element.

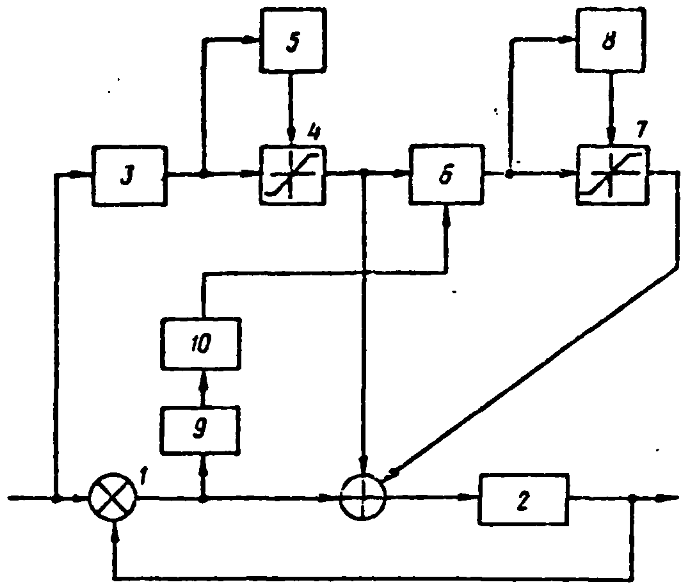

Fig. 1

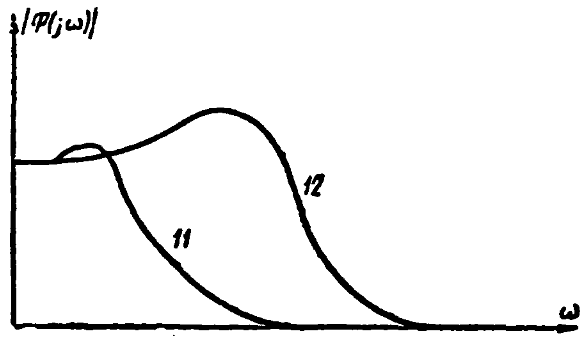

Fig. 2